CALICE-UK Report to the STFC Oversight Committee

December 21, 2007

1 Initial statement

The members of CALICE-UK were shocked to find the brief statement concerning the ILC in the STFC Delivery Plan[1]. We are also appalled to find that since this announcement, we have been given no official notification of how we deal with the major consequences of this decision which impact the members of our groups, our University Departments and our commitments to our collaborators.

We find the decision perverse in the extreme; we believe we satisfy most of STFC's stated key principles[2], namely:

- The highest quality science and technology, with investment focussed on enabling access to world-class facilities and the delivery of key technologies which will underpin science advances and technology transfer;
- A healthy and vibrant university community to exploit these facilities and technologies;
- International impact and credibility, recognising the increasing scope and need for international collaboration.

and so cannot see any sciencific reason why this particular project was targetted so harshly. We believe that such a major decision should only come after a period of consultation and peer review, and this has clearly not happened.

In the hope that STFC realise the error of this decision, we have decided to submit this OsC document as originally requested, outlining how we would plan to complete the work of this grant. If this is not possible, then the funding already spent on this grant will be effectively wasted, given that none of the workpackages was planned to be near to completion at this stage.

2 Introduction

The CALICE collaboration is a worldwide effort to study calorimetry for the International Linear Collider (ILC). The collaboration is described in more detail in Section 3 below.

UK involvement in CALICE started in 2002. The PPRP granted seedcorn funds for five groups in December of that year to join the collaboration. In February 2005, seven UK groups then returned to the PPRP for further funding to complete the ongoing programme of beam tests as well as start several longer-term R&D programmes, which were funded to March 2009.

The UK CALICE groups were also part of the successful EUDET infrastructure bid to the EU, which was approved in January 2006. This gives the UK funding to produce a DAQ system for reading out future calorimeter prototypes also being produced within the EUDET framework.

[1] http://www.scitech.ac.uk/resources/pdf/delplan_07.pdf
[2] http://www.scitech.ac.uk/About/Strat/Council/CSRResp.aspx

The individual workpackages are described in more detail in Sections 4 to 8. The Gantt charts, milestones, financial and risk tables are supplied separately and some related points are discussed in Section 9.

3 General status of CALICE

The CALICE collaboration is undertaking a major programme of R&D into calorimetry for the ILC, directed towards the design of an ILC calorimeter optimised for both performance and cost. It now has over 200 members from 43 institutes worldwide and is by far the largest group studying calorimetry for the ILC.

There are now only three ILC detector "concept groups", of which two are of a significant size. These two are also the ones which have calorimeters based on particle flow (PFA) concepts, the approach supported by CALICE. The aims of the concept groups are supposed to be to evaluate and compare the physics potential in the context of a full detector of the various ideas coming from the (separate) R&D groups.

The reduction in number occured when the LDC and GLD groups decided to merge to form the ILD collaboration[3] which is mainly European and Asian, while the SiD collaboration[4] is mainly based in the US. CALICE tries to have a strong contribution to both of these groups.

3.1 Prototype programme

The collaboration has tested a silicon-tungsten electromagnetic calorimeter (ECAL) in beams at DESY in 2006 and at CERN in both 2006 and 2007. For the latter, the scintillator steel analogue hadron calorimeter (AHCAL) and tail catcher and muon tagger (TCMT) were also present. Compared with the CERN 2006 run, the 2007 data had more complete detectors, with the AHCAL fully instrumented and the ECAL 93% complete.

The plan for 2008 is to fully complete the ECAL and install the detectors as used for the CERN runs at FNAL. Data will be taken to cross-check the CERN results as well as extend the momentum range to lower energies. Following this, then the silicon-tungsten ECAL will be exchanged with a scintillator-tungsten ECAL to allow a direct comparison. Similarly, towards the end of the year, the AHCAL will be exchanged with an RPC-based digital hadron calorimeter (DHCAL), using the same mechanical structure and hence converter. This again allows a direct comparison of the performance of the detectors. All the UK work related to this is covered by WP1.

By mid 2009, then "ILC-like" prototypes, similar to the calorimeter modules currently being considered in ILC and SiD, will be manufactured and tested, with very significant input from WP4. These modules will use the UK DAQ system being developed in WP2 and it is intended that one or more layers of the ECAL will be exchangable with layers containing the second round MAPS sensors produced as part of WP3.

The whole ILC community is aiming towards production of the Letters of Intent (LoI) in 2008 and, more critically, the first round of Engineering Design Reports (EDR) in 2010. The latter should present a complete design for the ILC and detectors which could in principle then be approved. By this time, first results from the LHC should be indicating if there is a strong physics case for the ILC. Hence, this will be the time at which the project is shown to be essential for particle physics and hence approval will be strongly sought, or whether the physics from the LHC means a different machine is needed.

[3] http://www.ilcild.org/
[4] http://www-sid.slac.stanford.edu/

4 WP1: Beam Test Programme

This workpackage inevitably has a high degree of interaction with, and dependence on, non-UK groups. The summer of 2007 was dominated by participation in the main test beam runs of the combined CALICE physics prototypes at CERN. The UK groups have contributed strongly to this work, providing one of the two run coordinators, as well as experts in the DAQ system, monitoring and data analysis. Roughly one quarter of the shifts were run by CALICE-UK people.

4.1 Task 1.1: Support for beam tests

The beam test run at CERN in 2007 was very similar for the DAQ to that in 2006; the only significant change was the inclusion of more layers of both the ECAL and AHCAL, which required a longer readout time and hence some work to prevent the event rate dropping too low.

The beam test went very smoothly and the DAQ required little day-to-day maintenance during the run period. The rate of taking usable data when beam was present, averaged over the whole run period (including the start up), was over 80%, which is very high for a beam test.

The next task will be to install the DAQ at the FNAL beam line and to include the DHCAL readout in the DAQ. This work has started and will continue through much of 2008.

4.2 Task 1.2: DESY test beam

The analysis of the electron test beam from DESY, recorded in May 2006, has largely paused now. Preliminary results were documented in a CALICE analysis note and thereby approved for public presentation; for example they were shown in several talks at LCWS'07 in May 2007.

Publication of these results is pending. The original intention was to publish them along with the electron data recorded at CERN, in order to extend the lever arm in energy. However, there were some significant differences between the DESY and CERN data (beam halo and double showers at DESY, and some uninstrumented layers), which introduce uncertainties in comparisons between the data samples. We expect to record more low energy electron data at FNAL in 2008, and it may make more sense to compare these results with the CERN data for publication. The DESY analysis is therefore currently on hold at the preliminary results stage until the best publication strategy becomes clear.

4.3 Task 1.3: CERN test beam

Reinstallation of the ECAL and the AHCAL at CERN along with the TCMT took place in June 2007. This year a major problem arose – the AHCAL mechanical structure and the electronics racks and crates suffered significant damage in transit to CERN. Thanks to tremendous support from DESY and other groups, effective repairs were performed, and data taking started at the beginning of July as planned, and continued for seven weeks.

The ECAL was equipped to its full depth of 30 layers of sensors. For 24 layers, the full area of $18\times18\,\mathrm{cm}^2$ was instrumented, while for the first 6 layers, a reduced area of $12\times18\,\mathrm{cm}^2$ was equipped. This still allows good transverse containment of showers. Unlike 2006, the AHCAL was fully equipped with 38 layers of scintillator tiles, and the TCMT was also fully equipped with scintillator strips.

The aims for this run were comfortably fulfilled. Data were recorded with electron and positron beams from 6 to 50 GeV, and $\pi^{\pm}$ beams from 6 to 180 GeV. Some runs were also recorded with the possibility to separate pions from protons using the beam Čerenkov counters. The detector was rotated to angles 10°, 20° and 30° with respect to the beam, and scans were taken in which the beam was centred on different ECAL wafers, and on various positions at the boundaries and corners of wafers. Typically, around 3 million beam triggers were recorded per day, for a total of $\sim$ 200 million triggers and approximately 14 TB of data. Most of the data were recorded using the full system of ECAL/AHCAL/TCMT; some runs were taken without the ECAL for AHCAL calibration purposes.

The success of the 2007 test beam program has inevitably had some impact on plans to publish the results of the 2006 test beam. In the case of the ECAL analysis of the 2006 data, a substantial CALICE analysis note was written (coordinated in the UK), documenting results approved for public presentation. We are now preparing several papers based on this work. The first of these, describing the commissioning and technical performance of the ECAL, is being coordinated by a CALICE member at Imperial, is just entering its internal CALICE editorial approval process in preparation for submission for publication in NIM. This will be followed by several papers addressing the calorimeter response to electrons. Some of these papers will be based on the 2006 data, and should appear during the next few months, while other topics (for example uniformity of response across the calorimeter face, angular scans) may be better addressed using the 2007 data, and are consequently on a longer timescale. The first analysis paper is already in preparation, and should be submitted for publication in early 2008.

The analysis of the hadron data obviously relies on the HCAL and TCMT as well as the ECAL. The task of calibrating these detectors is significantly more complex than the Si-W ECAL, and has occupied the DESY group for around a year. Three analysis notes exploring the 2006 HCAL and combined data were produced in order to approve results for presentation at LCWS'07. We now have reconstructed files for the full 2006 data sample which will facilitate other groups getting involved in the analysis. First publications on the AHCAL are planned for the first half of 2008, but it is probable that these will be largely based on the 2007 data, since the HCAL was only fully instrumented in 2007. Indeed, some publications will probably be held to include also the data from the 2008 FNAL run, which will provide superior low energy data.

4.4 Task 1.4: FNAL test beam

There has already been CALICE test beam activity at FNAL in summer 2007 in which a small 9 layer RPC-based calorimeter was successfully tested. This is the first step towards a full-size RPC-based digital HCAL prototype, to be installed in the same iron stack as the AHCAL. The UK had some limited involvement in this test, mainly providing the monitoring software based on that used at CERN.

In 2008, the centre of CALICE test beam activity will move to FNAL, with a particular focus on lower energy beams. The response of the calorimeters to low energy hadrons is of particular importance for the ILC (the average hadron energy is typically $\sim$10 GeV, while higher energy showers obviously include many low energy hadrons). The AHCAL is currently being given permanent repairs at DESY, and will be shipped, along with the ECAL, to FNAL around February 2008. The first plan will be to run with same configuration as at CERN in 2007, at high energies for long-term stability checks against the CERN results, but with particular emphasis on low energy hadrons and electrons. The CALICE-UK groups expect to be fully involved in these tests, which we anticipate running in spring 2008, and in the subsequent analysis of the data, which will take place over the following year or so.

Subsequently, this setup will be used to test other detector technologies. The Japanese CALICE groups are building a scintillator-tungsten ECAL, which they intend to test along with the AHCAL and TCMT, while the DHCAL groups also plan to test all or part of the DHCAL prototypes based on RPCs and GEMs. These are important and interesting tests, but in view of the timescale of these activities, and the timescale of the approved CALICE-UK programme, our participation will probably be largely limited to supporting the DAQ and monitoring infrastructure.

4.5 Milestones

The milestones for 2007 onwards are:

- **Milestone ID27: "Present interim results at LCWS'07"** (31/05/07). Achieved.
- **Milestone ID14: "Complete analysis of DESY data"** (29/06/07). Done, in the sense that the analysis to date has been documented, presented at workshops, and placed on hold awaiting a decision to publish or supersede by FNAL data. Of course, further ideas may prompt new work on these data.
- **Milestone ID20: "Successful end of 2007 CERN test beam run"** (31/07/07). Completed 22/08/07.
- **Milestone ID24: "Submit paper on electron results"** (31/03/08). Pretty much on track for the first two papers. Of course, this is not just a decision for CALICE-UK; we have to satisfy internal scrutiny and approval procedures. There will probably be further papers.
- **Milestone ID33: "Successful completion of FNAL test beam run"** (15/12/08). We can be confident about those parts of the program involving the Si-W ECAL and the AHCAL, and also the scintillator-W ECAL. The timescale of the US-built DHCAL prototypes is less certain.
- **Milestone ID37: "Submit paper on hadron results"** (28/09/09). This will almost certainly turn into a series of papers, the first of which should appear in the first half of 2008. The CALICE data will be a valuable resource, which we and our collaborators will surely continue to exploit even after 2009.

4.6 Application for extension of WP1 post

We should like to use part of the Working Allowance to fund a six-month extension of the PDRA post held by Dr G. Mavromanolakis at Cambridge, at an estimated cost of £28k. Dr Mavromanolakis has been actively involved in all of the CALICE test beams from the very beginning in early 2005, and is now one of our most senior experts. One particular responsibility is the online monitoring, which has been an essential tool in identifying and diagnosing problems at run time. This will need upgrading to incorporate new detectors in 2008. He is also the only CALICE-UK member who has been active in this year's test beam work at FNAL. In the light of the upcoming activity at FNAL in 2008, this would be an unfortunate time to lose his skills. He is also actively involved in the data analysis activities.

5 WP2: DAQ

5.1 EUDET work

As well as meeting the goals of the grant awarded by STFC, this workpackage needs to achieve the work programme set out in the EUDET project. This will put the UK at the forefront of DAQ activities for the calorimeter (if not wider) and place us in a position to build the DAQ for the final detector when it is constructed. The effort in EUDET concentrates on providing a technical prototype by the beginning of 2009 at which point we should have a working DAQ system to readout this detector.

As in the previous report, the proposed DAQ stream is shown for the EUDET prototype calorimeters. The design will again be explained here, but also the responsibilities of each institute for the specific part of the system. These responsibilities are then just put under the umbrella of the institute's respective task below. Providing this system as a whole becomes the most important goal as time goes on and is reflected in the new Gantt chart, which extends up until the end of 2009, which is the end of the EUDET programme.

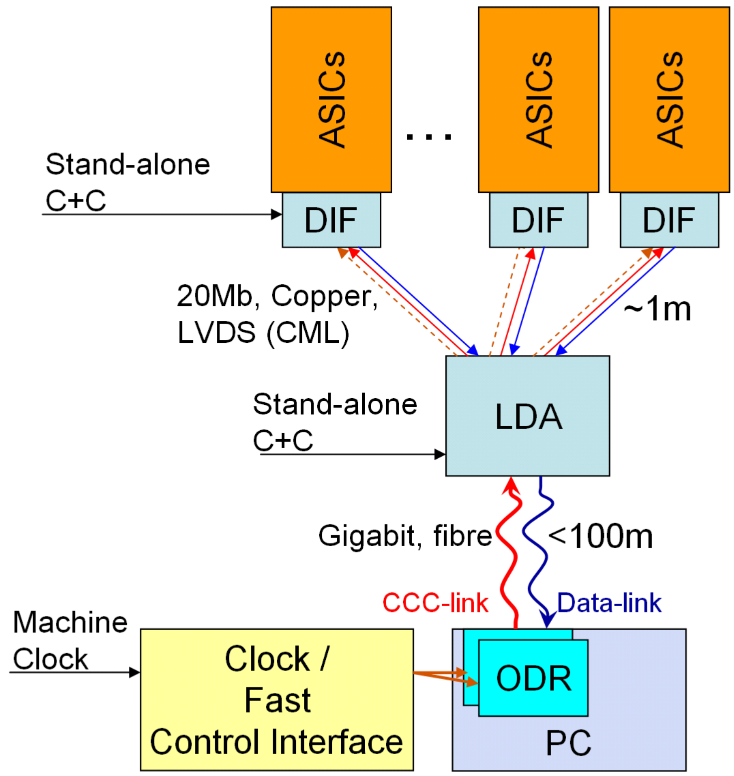

Figure 1: DAQ stream for EUDET prototype modules.

At the end of the detector slab, the data will be aggregated and transported off the detector via calorimeter-specific electronics, called a DIF (Detector InterFace). The DIF for the ECAL is being designed and built by the Cambridge group and is discussed in Task 2.2. The data will then pass to a Link/Data Aggregator (LDA) which is a generic piece of electronics used by all calorimeter systems, which will serve multiple DIFs. This is being provided by the Manchester group and is discussed in Task 2.3. A high-speed optical link will then transfer the data to the off-detector receiver (ODR). The ODR (RHUL and UCL), along with the clock and control interface (UCL) was already foreseen as part of the programme and so is discussed in Tasks 2.5 and 2.4, respectively. Finally the DAQ software (Manchester, RHUL and UCL) is also under development and is discussed under a new task heading.

5.2 Task 2.1: Readout of prototype VFE ASICs

Due to delays in the production of ECAL chips, this task has been continually delayed. The work structure as originally planned has therefore been retired. Characterisation of the chips is nevertheless still an important task, and so will be carried out at a later date, as an early part of the overall system integration tests for the complete EUDET system. The work will use the hardware and some firmware developments ongoing at Cambridge for the final system of electronics at the end of the prototype calorimeter slab. Therefore no extra dedicated equipment will be needed and in order to perform their tests, the Imperial group will contribute to firmware development for the final system. The firmware development will start towards the end of 2008, with multi-chip testing in the first three months of 2009.

5.3 Task 2.2: Study of data paths over 1.5 m slab

This task is ahead of schedule with all sub tasks up to and including the milestone ID 23 completed. The assembled board is shown in Fig. 2. Tests are starting on the assembled board and results should be available soon.

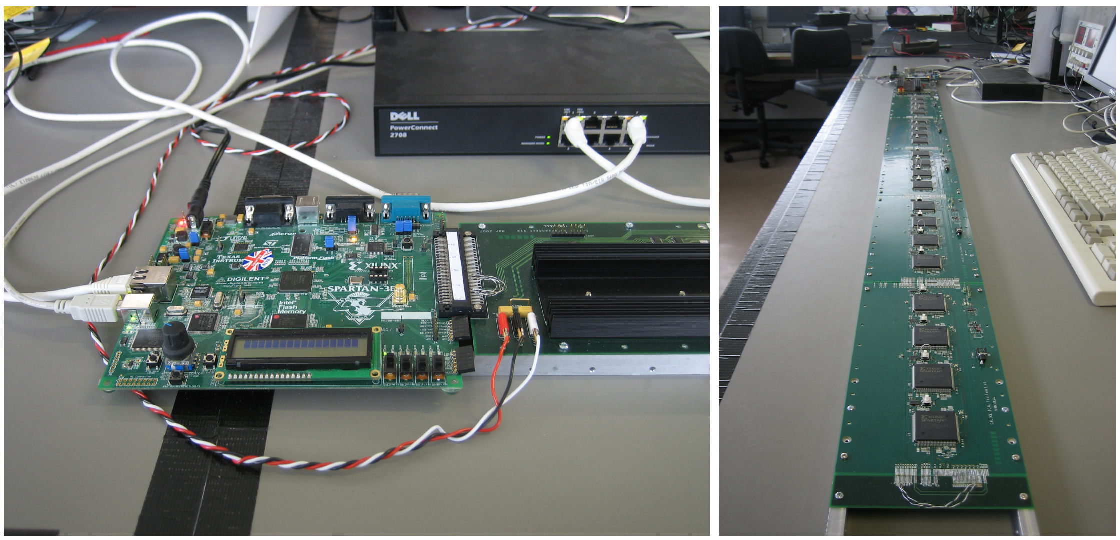

Figure 2: Full-length test board assembled at Cambridge, showing the end-of-slab electronics and the 1.5 m extent.

The task of assessing issues connected with long PCBs has been reduced in scope due to the building of the prototype in 2008 within the EUDET project. Therefore the results derived from this test-slab will feed directly into this design, but there will not be a second round of testing and also fewer tests will be performed with the current set-up.

The Cambridge group have therefore also been working and will then focus on providing the end-of-slab electronics for the ECAL as well as expertise and consultation on the design for the other calorimeters. This is in collaboration with the French groups who are building the detector. Progress has been made on the definition of interfaces both towards the detector slabs and back towards the LDA, as encompassed in IDs 17-19 in the new Gantt chart. The end-of-slab electronics shown in Fig. 2 is a preliminary version of what will become the DIF block in Fig. 1.

5.4 Task 2.3: Connection from on- to the off-detector receiver

For the conventional, high-speed networking, the work on the 10 Gbit switch has been pushed back in favour of the Manchester's commitment to provide the LDA for the EUDET DAQ system. The 10 Gbit network is not time critical and does also not feed directly into other work, so could be safely moved in priority.

The task of the LDA, as the name suggests, is to aggregate data, with the minimum of manipulation. This should serve as many DIFs as possible in order to have as few gigabit links as possible to the ODR, which is the most expensive component. They will be located as close as possible to the detector and (the prototype) will read in data from 10 DIFs, which may be increased to 50 connections, depending on needs. The LDA will also fanout clock, control and configuration signals to the DIFs. For the prototype LDA, a commercial FPGA development board (a Broaddown2 from Enterpoint[5] with a Xilinx Spartan3-200) has been ordered. Immediate work will focus on firmware development and enabling the link between the LDA and the DIF. Then focus will turn to the other links, to the clock, control and configuration hardware, and to the ODR. The LDA will then be integrated into the final DAQ system.

For the optical switch, work is progressing roughly on schedule: the test-rig (ID 57) has been set-up and IDs 58 and 59 are progressing, although on slightly different timescales. The switching speed specifications have been achieved and work has been ongoing with the supplier to improve their firmware controls. More detailed results are expected in the next few months.

5.5 Task 2.4: Transport of configuration, clock and control data

This task has followed very different timescales to originally planned mainly due to the influence of providing a working system for the EUDET prototype. Hence the work on remote configuration hardware (IDs 71-73) has been pushed back as this is not time-critical, although it will still be done. Work has started on the design and build of hardware to provide the machine clock and fast signals to the ODRs or LDAs. The use of a commercial fanout (ID 79) appears to be difficult, so a custom protocol on a fibre-optic link is being considered. The jitter has also been considered (ID 78) in making hardware choices. Therefore IDs 81 and 82 have been started before time at the expense of some of the other work.

5.6 Task 2.5: Prototype off-detector receiver

This task is on progressing well, with ID 91 complete and IDs 92 and 93 on schedule. Work is ongoing to optimise the performance for data transfer and write to disk. Future work will concentrate on the ODR used in the optical switch test-rig both as a data source as well as a receiver. As the ODR will also have to send data up to the detector for the EUDET technical prototype, enabling it to be a data source is anyway necessary. Tests will also be performed with multiple cards, which will be another step towards integrating into the DAQ system for the technical prototype.

5.7 Task: DAQ software

In order to control the DAQ hardware in a test-beam environment with the EUDET technical prototype, DAQ software needs to be written. A survey of various software and run-controls has been made. As our system is quite large and contains several different detectors, flexible, adaptable and maintainable software was sought. This means preferably something which is also used and developed elsewhere, rather than just in-house developed software for specific tasks. It should then be possible to port this software to other environments and for use with different detectors. The software chosen is DOOCS[6], which has been developed in DESY for accelerator control systems, in particular the TESLA test facility. Work has started in collaboration with the developers at DESY. The next steps are to define the hardware interfaces.

[5] www.enterpoint.co.uk/

[6] http://tesla.desy.de/doocs/doocs.html

6 WP3: MAPS Development

6.1 Workpackage status

The MAPS project has continued to make good progress since the last OsC meeting. The first round sensor was returned from fabrication in early July 2007, just before the last OsC meeting. Since that time, extensive tests have been carried out on the sensors to measure their performance. The basic tests have effectively now been completed, fulfilling ID11 of the Gantt chart, while more detailed tests continue. All results shown below are very preliminary.

6.1.1 Test structure tests

Each sensor had three pixels fabricated in a test structure outside of the bulk pixel array. These three pixels were of the "pre-sampler" type and, unlike the bulk pixels, their analogue outputs before the comparators were accessible externally.

Using a laser system at RAL, then the analogue signal seen from the test pixels was measured as a function of the laser position. A laser pulse intensity was chosen to give a deposited charge in the epitaxial layer of approximately the size of a MIP signal. The same measurements were performed using a sensor fabricated without the deep p-well process; this process had been developed as part of WP3 specifically to improve charge collection efficiency. Figure 3 shows the response to the laser for a scan over the surface of the test pixels.

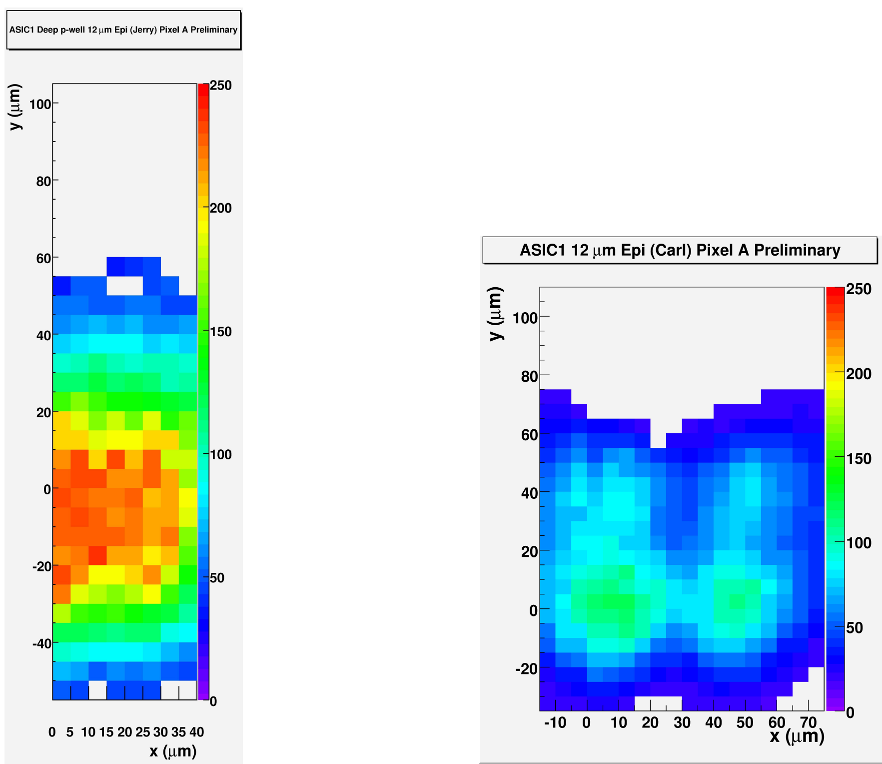

Figure 3: Analogue response of one of the test pixels as a function of the laser position. Left: a sensor with the deep p-well process. Right: a sensor without the deep p-well process. The colour scale is set to be identical for the two diagrams, although note the x and y scales are not.

It is clear the signal response is both larger and much more uniform for the sensor with the deep p-well process; indeed, the non-uniformity of the sensor without the deep p-well shows the position of the four charge collection diodes, as the efficiency peaks for charge deposited close to them. These results were reported at the recent IEEE meeting in Hawaii[7].

6.1.2 Radioactive source tests

The bulk pixels of the sensors have been exposed to a thallium (204Tl) β source ($Q = 764\,\mathrm{keV}$) at Imperial. Because the sensors have binary readout, then data runs are performed where the threshold is scanned in software to study the response as a function of the threshold setting. Figure 4 shows the results from one such run.

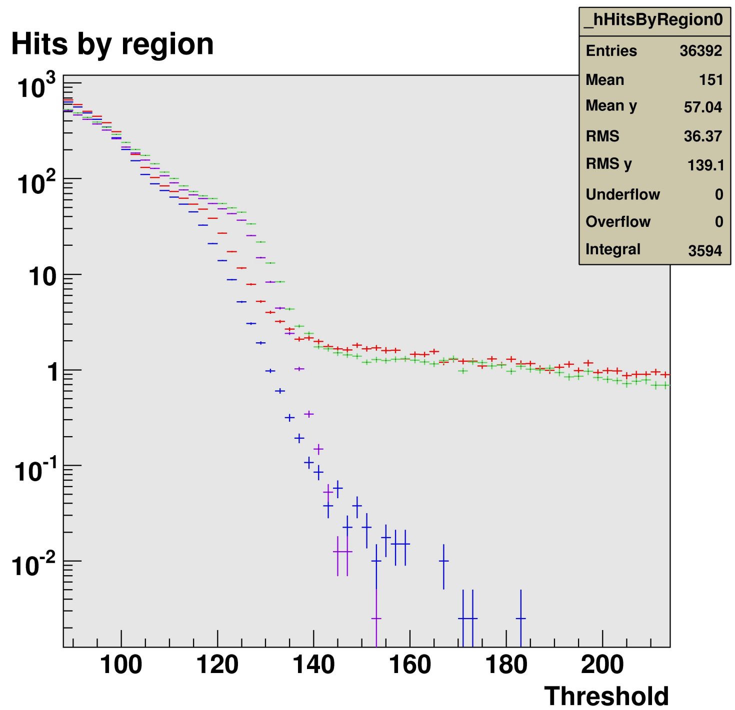

Figure 4: Number of binary hits recorded from two readout regions of the sensor as a function of the applied threshold (in units of the DAC code used to set the value). The blue and purple data points show the numbers with the source absent for regions 0 and 1, respectively. The red and green points show the corresponding regions when the source is present.

This figure shows a clear signal for the source hits in the bulk pixels. It also allows the absolute noise rate to be derived. These data were taken with a bunch train length of 5000 bunch crossings and there are approximately 7000 pixels in a region. This means the target noise rate of 10^{-6} hits per bunch crossing per pixel would give 35 hits per bunch train per region. It is clear this can be achieved with a threshold in the region of 120-130 units.

6.1.3 DESY beam tests

The sensors were exposed to beam at DESY in the week of Dec 10-17, a few days before the submission of this document, completing Gantt chart item ID13. A stack capable of holding

[7] J.P.Crooks et al, "A Novel CMOS Monolithic Active Pixel Sensor with Analog Signal Processing and 100presented at IEEE-NSS, Honolulu, Hawaii, Oct. 2007, and submitted to the proceedings thereof; M.Stanitzki et al, "A Tera-Pixel Calorimeter for the ILC", presented at IEEE-NSS, Honolulu, Hawaii, Oct. 2007, and submitted to the proceedings thereof.

up to four sensors accurately aligned was made at Birmingham and mounted in the beam line. With all four sensors inserted, this was run in electron beams from 3 to 6 GeV, with and without tungsten converters in front of the sensors. Clearly, at the time of writing, the data have not been analysed to any significant extent, but as an example Fig. 5 shows the correlation of hits in the x direction of the first two sensors layers when running without any converter material.

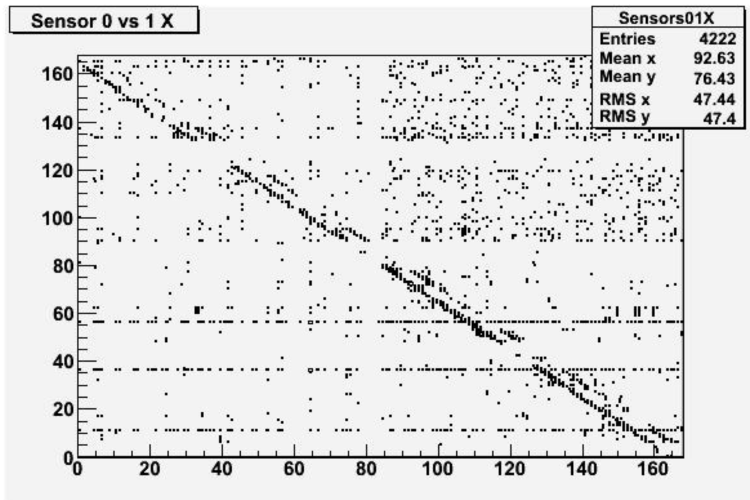

Figure 5: Correlation of pixel hits in the x direction for the sensors in the first two layers, with no tungsten present. The orientation of the sensors was alternated in each layer, so the x hits are anti-correlated. The double band structure needs to be understood but may be due to a mechanical shift.

A clear correlation is seen, corresponding to through-going tracks parallel to the beam axis. This gives an indication that meaningful results are to be expected from the data taken.

6.2 Plan for completion of WP3

WP3 has been running around three months later than originally planned for over a year, since the delay due to the development of the deep p-well process. Due to this and some other external influences, we would like to extend the project beyond the end of the current grant period by six months, using the Working Allowance to cover the extra costs.

This takes the project up until the end of September 2009. This date is chosen so as to be able to do the beam test of the second sensor as planned in the original proposal. Specifically the plan was to have one or two full layers of sensors substituted for an equal number of layers of standard ECAL diode pad silicon wafers in a full prototype calorimeter. This will allow a direct comparison of the behaviour of the two systems. However, the plans for the standard ECAL prototype have changed since the proposal was submitted. The ECAL tests will now take place within the EUDET structure and instead of starting in September 2008, they are scheduled to start only in June 2009. Hence, to be able to do this test, the WP3 project will need to be extended up to September 2009, allowing time for data collection and analysis.

Therefore WP3 will require almost two more years to complete its tasks due to changes in the external schedules. Therefore, the rest of the project has been rescheduled to sensibly fit into the time available, given the extension to the end date and the possibility of extension raised at the last OsC meeting. This has been done while conserving the constraint that the RAL Sensor Design Group effort should not exceed the amount granted.

The next steps are to produce a second round of sensors in 2008. There will be three reviews during the second sensor design period. The preliminary design review will define what the second sensor will contain and is the time when we will make choices about which pixel variant to use, how much memory (and hence dead area) is acceptable, the pixel size, etc. The interim design review will then be held to review the schematics before moving to the layout design. The final design review will be held shortly before submitting the sensor for fabrication, to check the schematics for changes since the interim review and to review the layout.

The tests for the second sensor will be similar to those for the first, as described above. Since the comparison beam test will be delayed until summer 2009 due to the EUDET schedule, there will also be a stand-alone beam test of at least four second sensor layers, similarly to the one just completed for the first sensors. It will resuse the existing mechanical structure.

There is one PDRA funded by CALICE (Dr A.-M. Magnan) who is considered essential for the success of the MAPS project. Her current contract finishes at the end of October 2008. Therefore, given the extension of the effort to the end of September 2009, we will need to extend her contract by nine months at an estimated cost of £40k. This would allow her to stay until the end of June 2009.

6.3 Milestones

The future milestones below are discussed relative to the schedule described in the section above.

6.3.1 Milestone ID9: "First sensor fabrication complete"

This was completed in July 2007, as reported at the last meeting.

6.3.2 Milestone ID15: "Second sensor preliminary design review"

This will be held early in the second sensor design period and is expected to occur in January 2008. Enough results from the first sensor must be known so at to be able to make choices for the second sensor design.

6.3.3 Milestone ID16: "Second sensor interim design review"

This is the schematics review of the second sensor design. This will occur half way through the design phase and is scheduled for April 2008.

6.3.4 Milestone ID17: "Second sensor final design review"

This is the layout review of the second sensor design. This will occur towards the end of the design phase and is scheduled for June 2008.

6.3.5 Milestone ID18: "Second sensor design to foundry"

This marks the completion of the second design and will be a month after the final design review, in July 2008, to allow time for any outstanding issues identified in the review to be implemented.

6.3.6 Milestone ID20: "Second sensor fabrication complete"

This is the expected date for the sensor to be returned and is in October 2008.

6.3.7 Milestone ID25: "Second sensor beam tests start"

This is mainly determined by the EUDET schedule but also needs to allow all the sensor tests to be completed so the sensor operation is understood. The beam tests are scheduled to begin in June 2009.

7 WP4: Thermal and Mechanical Studies

As we outlined in the previous report to this committee, with the completion of the long-term glue test, WP4 will now focus on mechanical issues concerning construction and integration of the ECAL. There are tasks in the work package, both aligned with the EUDET module construction work being carried out in collaboration with our French colleagues.

Firstly, we will undertake the task of attaching the silicon sensors to the ASUs (the short PCBs that are stitched together to make the full-length slabs) and testing each assembly before shipping them to France for final assembly. Details of the timeline for this task are shown in the Gantt charts. The modules will be assembled using conductive glue to attach the sensors to the PCBs which carry the readout ASICs. The first half of next year will be taken up with construction of the required tooling to handle the wafers and PCBs and testing with the Manchester glue robot to ensure that glue dots of the required size and thickness can be reliably obtained and reproduced. In parallel a test stand will be developed (using readout electronics from the French groups) to test the final assemblies. Whilst this is initially envisaged to be a cosmic test stand, depending on the nature of the external trigger input to the electronics we may have to use a laser or other means of charge injection for testing. Once final silicon sensors become available (expected around the beginning of April 2008), tests will be carried out to ensure our quality-control systems are adequate before moving on to full production in the latter half of next year. This will ensure that sufficient quantities of assembled and tested assemblies are ready for integration into the EUDET module in 2009.

The other task for this work package is to design the services layout for the end of the EUDET module. The UK is designing the DIF and LDA electronics for the ECAL, so it is natural that we undertake the layout of the power and DAQ cabling on the ECAL prototype. Since space is at a premium in this region, we will also integrate the front-end cooling system into the module layout. This task will be undertaken in the first half of 2008. Although a smaller part of the work package, this is an important task that will involve the UK directly in the integration studies for ILC detectors, a role we see as being of strategic importance over the coming years as we move into the detector EDR phase.

7.1 Review of Milestones

WP4 has achieved its major milestone this year of reporting on the suitability of conductive glue for sensor attachment to the PCBs. A verbal and written report was delivered at LCWS at DESY in the summer. Future milestones are indicated on the revised Gantt charts and are now focussed on assembling the electronics modules for the EUDET detector prototype.

7.2 Plan for Completion

The tasks descriptions above outline the programme to completion. The obvious major risk is the delivery timescale of the silicon wafers and associated PCBs. We will be ready to carry out assembly of the modules in time for delivery of the first sensors - based on our best estimates from the French groups. However, any delays in this schedule will directly impact our timeline. The EUDET module will be completed by the end of calendar year 2009, so there is a risk that we may need technical staff effort past the formal end of the project in March 2009. However, the technicians who will carry out the work in Manchester are all funded from the group rolling grant and will thus be able to continue assembly without recourse to further funding from this project - it would be highly desirable to include this mechanical work in the next round of bids to STFC as part of an enlarged mechanics and integration work package for the detector EDR phase.

8 WP5: Physics and simulation studies

There have been discussions about combining the effort on physics studies of the UK groups on both the CALICE-UK and LCFI detector projects in a future proposal. Because of the need to produce the LoIs during 2008 and the EDRs by 2010, the number of ILD and SiD detector meetings will increase significantly in the near future. Hence, it was thought this would be the right time to combine the studies so as to make the most efficient use of the available effort.

However, because of the current funding issues, these plans are now very uncertain. It is hoped that this will be clearer by the time of the OsC meeting itself and a report will be given at that time. Hence, at this time, the only Gantt chart which is sensible to supply is the one for the original schedule.

9 Financial and managerial issues

The Gantt charts, financial tables, risk proforma and milestone tables are supplied separately. We continue to hold bi-monthly phone meetings of work-package managers and the project manager at which these tables and other managerial matters are discussed.

9.1 The financial tables

The tables presented at this meeting give the financial status as of the end of 2007/8 Q2. They are in the new style as requested by the Office. The penultimate column gives the amount remaining and the final column gives our current prediction of the underspend or overspend in each line of the project.

Column 3 indicates transfers made to date, both discussed at the previous OsC meeting: £15k from the WA to fund the project additional cost arising from the development of the new process for the MAPS sensors, and the transfer between UCL and RHUL arising from the EUDET income. We project a small net underspend of effort before the requests for extensions of PDRAs made in this report are considered. These requests total £68k and are not included in the financial tables.

We currently anticipate spending all equipment, travel and consumables funds by the end of the project. In particular, significant test beam running at Fermilab in 2008 will require the use of the travel underspend from previous years.

9.2 The Gantt charts

As requested at the last OsC meeting we present two versions of the Gantt charts: (a) continuation of the previous charts showing progress to date, (b) new charts containing refinements to workpackages and updated milestones. Progress against the Gantt charts is discussed for each workpackage in the main body of this report.

9.3 The risk table

Changes since the last meeting are highlighted. However this table is completely outweighed by the risk from STFC that the project will be terminated. There appears to be no appropriate score for this particular risk.

9.4 The milestones tables

These are provided for the first time in the requested format. In these tables we use the word “achieved” to mean that the milestone was complete as scheduled and “completed” to mean that it is complete but delayed compared with the original schedule. Any changes to the schedule of any milestones are shown in bold.

10 Summary

During the time since the last OsC meeting, CALICE has made excellent progress. Despite a very difficult start to the 2007 CERN beam test run, we succeeded in taking a huge dataset of good quality electron and pion data.

For CALICE-UK, all workpackages have continued to make good progress since the last meeting. They are all on, or reasonably close to, schedule and no milestones have been missed by more than three months, showing there have been no further delays to the workpackages since the last OsC meeting.

A plan to completion, which uses the Working Allowance to extend two of the RAs into 2009 to cover the extended test beam period has been developed and will allow us to extract the maximum benefit for the investment made so far.